A new Audacity feature: room objective acustical parameters calculation module

Angelo Farina Simone Campanini

Università degli Studi di Parma - Facoltà di Ingegneria

Linux Audio Conference, 2009

Contents

Introduction

Some reasons for a port:

- need for platform independent measuring tools
- need to go beyond the limits of a closed source main application

The First Attempt

Acoustical Parameters

- is an independent module
- has a complex window $\longrightarrow$ many functions can be reused for other modules

Room Acoustic Project

Main targets:

- Good listening for the audience.
- Good feedback for the speakers or the musicians.

Subjective vs. Objective

Listening is a subjective fact,

but

can be a project *subjective* ?

A set of objective acoustical parameters is needed!

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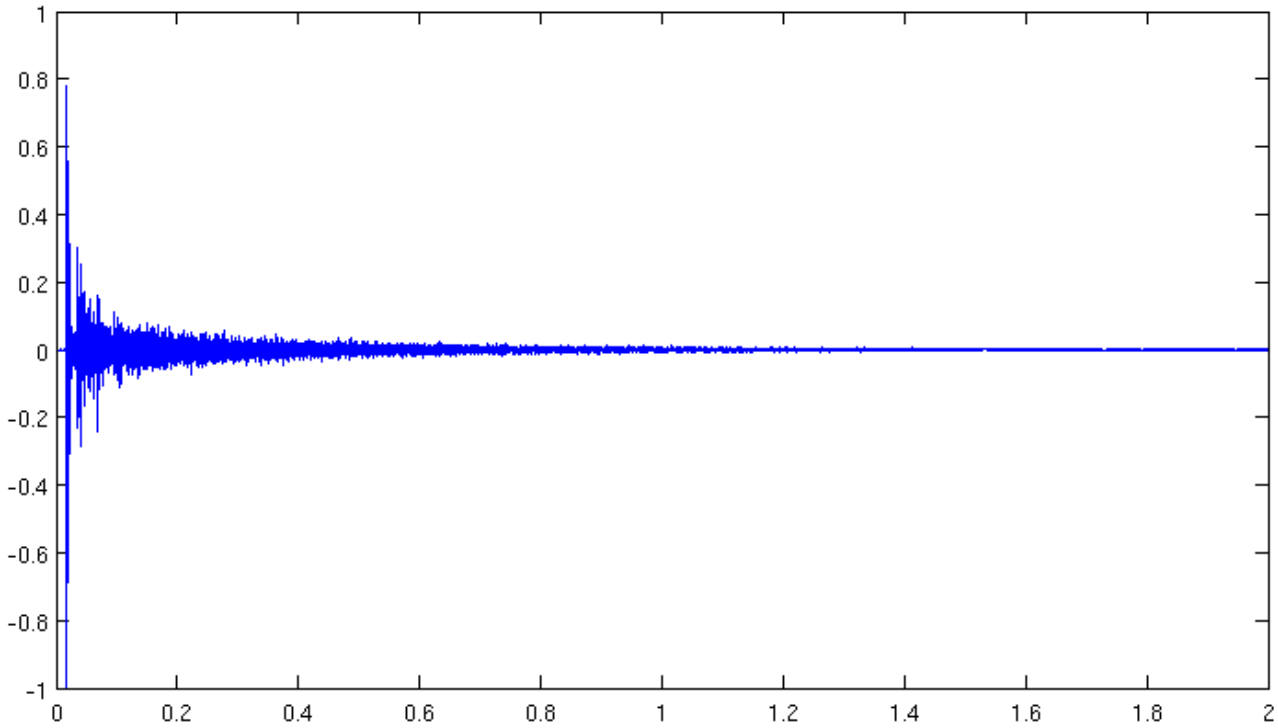
Acoustical Parameters

Many acoustical parameters has been tested in the second half of 20^{th} century.

$\Downarrow$

An important set of them is collected in the ISO 3382 standard.

A Room Fingerprint: The Impulse Response



Reverberation Time

$$T_{60}$$

Time needed by the sound pressure to decrease by 60 dB from a steady level.

Clarity And Definition Indexes

$$C_{t_e},\ D_{t_e}$$

They are logarithmic ratios between a fraction and the entire (or the remaining) IR energy.

t_e can be 50 ms or 80 ms: the first for speech, the latter for music.

Sound Strenght

$$G$$

It is a logarithmic ratio between the energy of the measured IR and a reference one.

It gives a measure of *how much* the environment increases (or decreases) the perceived loudness of a sound.

Spatial Indexes

LF, *LFC*, *LG*, *IACC*

They give a listener surround capabilities measure of the room.

It is needed a more complex recording equipment:

- Omidirectional + Figure-of-eigth microphones (*LF*, *LFC*, *LG*).
- Binaural microphone (*IACC*).

Stage Parameters

$$ST_{\text{Early}}, ST_{\text{Late}}$$

They are logarithmic ratios between early or late energy and the early one (first 100 ms) of the IR.

They are performer indexes

Aurora: A Multipurpose Plugin Suite

Aurora is a toolkit for Adobe Audition® written by Angelo Farina.

It includes:

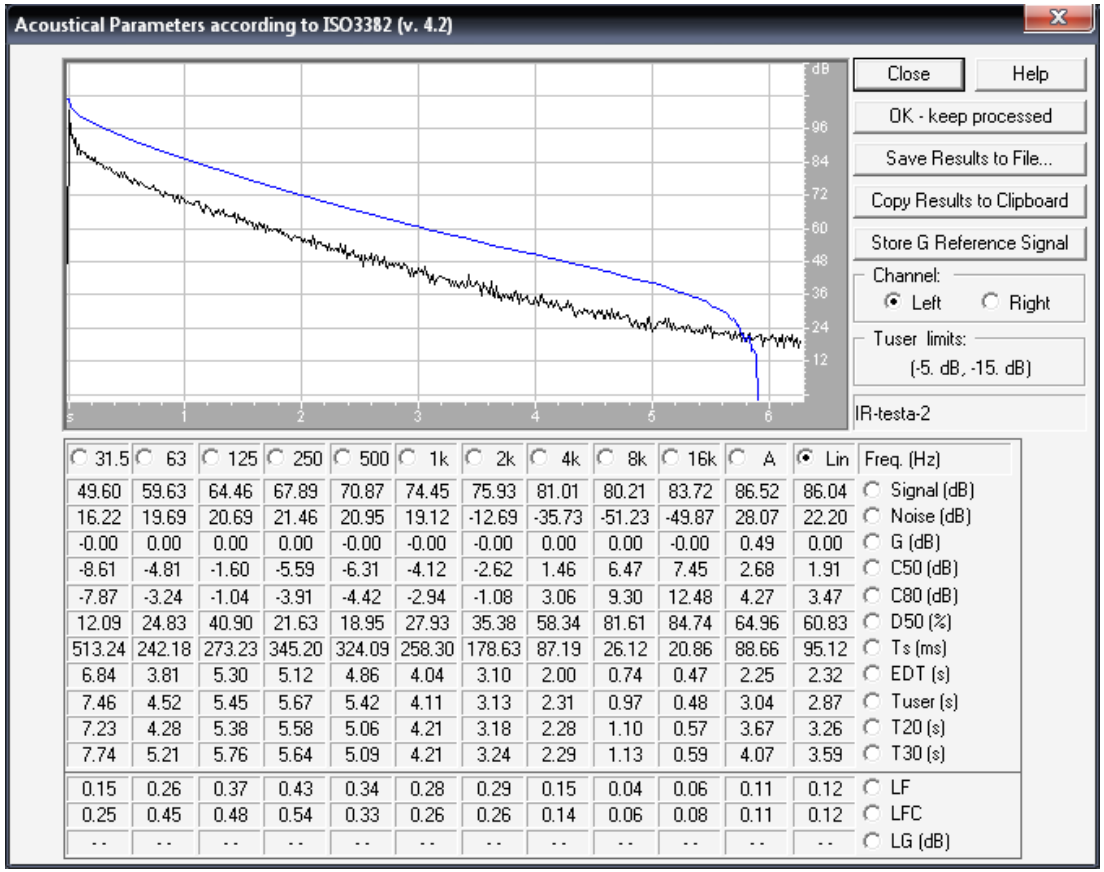
- ISO 3382 Acoustical Parameters calculator
- toolset for measurements with MLS technique
- toolset for measurements with *SineSweep* technique
- various convolution tools
- Speech Transmission Index (STI) calculator
- ...

The Original Implementation

Since its first release *Aurora* is

- written in plain C code
- implemented as XFM *Cool Edit* plug-in
- available only on Windows platforms

The *Acoustical Parameters* module window



31.5	63	125	250	500	1k	2k	4k	8k	16k	A	Lin	Freq. (Hz)
49.60	59.63	64.46	67.89	70.87	74.45	75.93	81.01	80.21	83.72	86.52	86.04	Signal (dB)
16.22	19.69	20.69	21.46	20.95	19.12	-12.69	-35.73	-51.23	-49.87	28.07	22.20	Noise (dB)
-0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00	0.00	-0.00	0.49	0.00	G (dB)
-8.61	-4.81	-1.60	-5.59	-6.31	-4.12	-2.62	1.46	6.47	7.45	2.68	1.91	C50 (dB)
-7.87	-3.24	-1.04	-3.91	-4.42	-2.94	-1.08	3.06	9.30	12.48	4.27	3.47	C80 (dB)
12.09	24.83	40.90	21.63	18.95	27.93	35.38	58.34	81.61	84.74	64.96	60.83	D50 (%)
513.24	242.18	273.23	345.20	324.09	258.30	178.63	87.19	26.12	20.86	88.66	95.12	Ts (ms)
6.84	3.81	5.30	5.12	4.86	4.04	3.10	2.00	0.74	0.47	2.25	2.32	EDT (s)
7.46	4.52	5.45	5.67	5.42	4.11	3.13	2.31	0.97	0.48	3.04	2.87	Tuser (s)
7.23	4.28	5.38	5.58	5.06	4.21	3.18	2.28	1.10	0.57	3.67	3.26	T20 (s)
7.74	5.21	5.76	5.64	5.09	4.21	3.24	2.29	1.13	0.59	4.07	3.59	T30 (s)
0.15	0.26	0.37	0.43	0.34	0.28	0.29	0.15	0.04	0.06	0.11	0.12	LF
0.25	0.45	0.48	0.54	0.33	0.26	0.26	0.14	0.06	0.08	0.11	0.12	LFC
--	--	--	--	--	--	--	--	--	--	--	--	LG (dB)

The Multiplatform Way: Compatibility Issues

Why *Audacity* ?

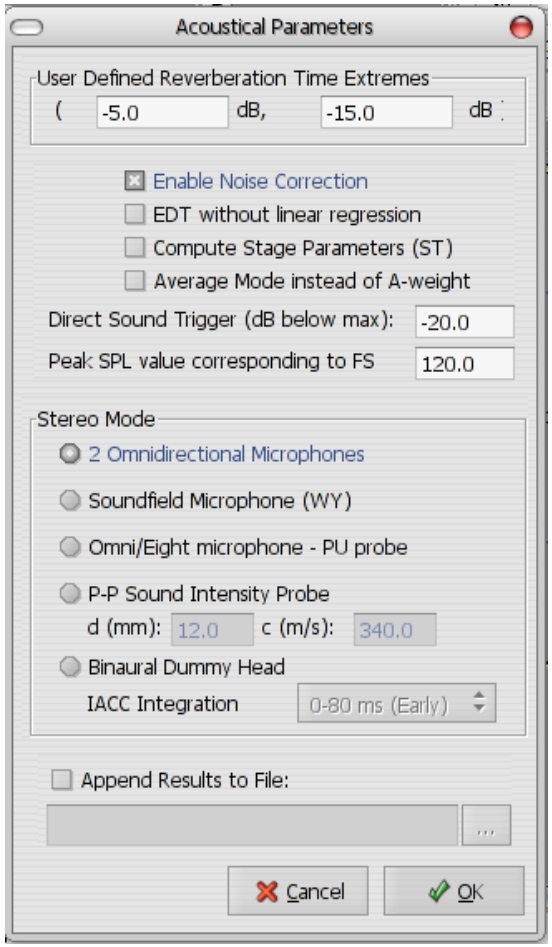
- It is a multiplatform application
- It is a good quality software, with a growing set of features
- It is open-source

The Porting Process

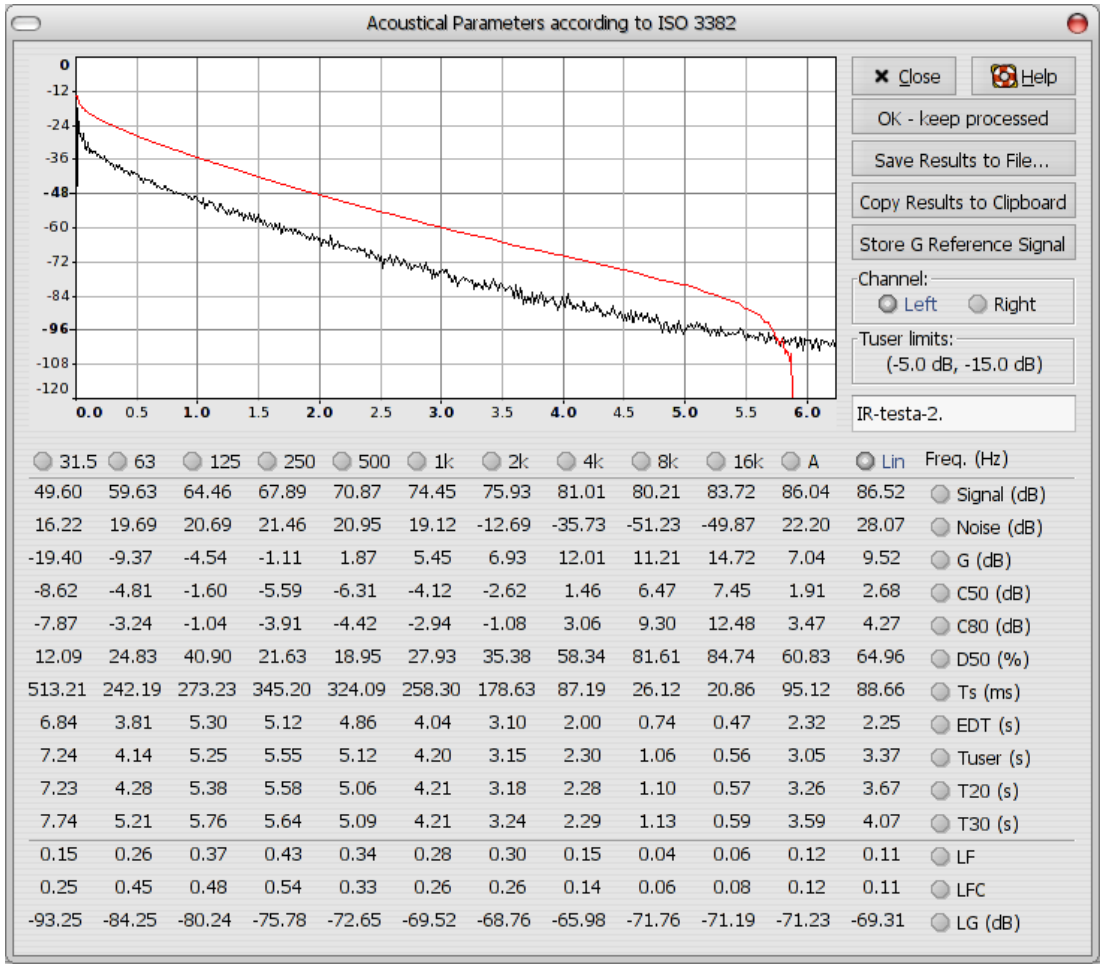
Some steps has ben followed:

- General code reordering
- Conversion from C to C++
- Conversion of GUI functions to wxWidgets ones
- Implementation as external *Audacity* library (thanks to *Audacity* developers group!)

Aurora For Audacity: Setup Window



Aurora For Audacity: Main Window



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16.22	19.69	20.69	21.46	20.95	19.12	-12.69	-35.73	-51.23	-49.87	22.20	28.07	Noise (dB)
-19.40	-9.37	-4.54	-1.11	1.87	5.45	6.93	12.01	11.21	14.72	7.04	9.52	G (dB)
-8.62	-4.81	-1.60	-5.59	-6.31	-4.12	-2.62	1.46	6.47	7.45	1.91	2.68	C50 (dB)
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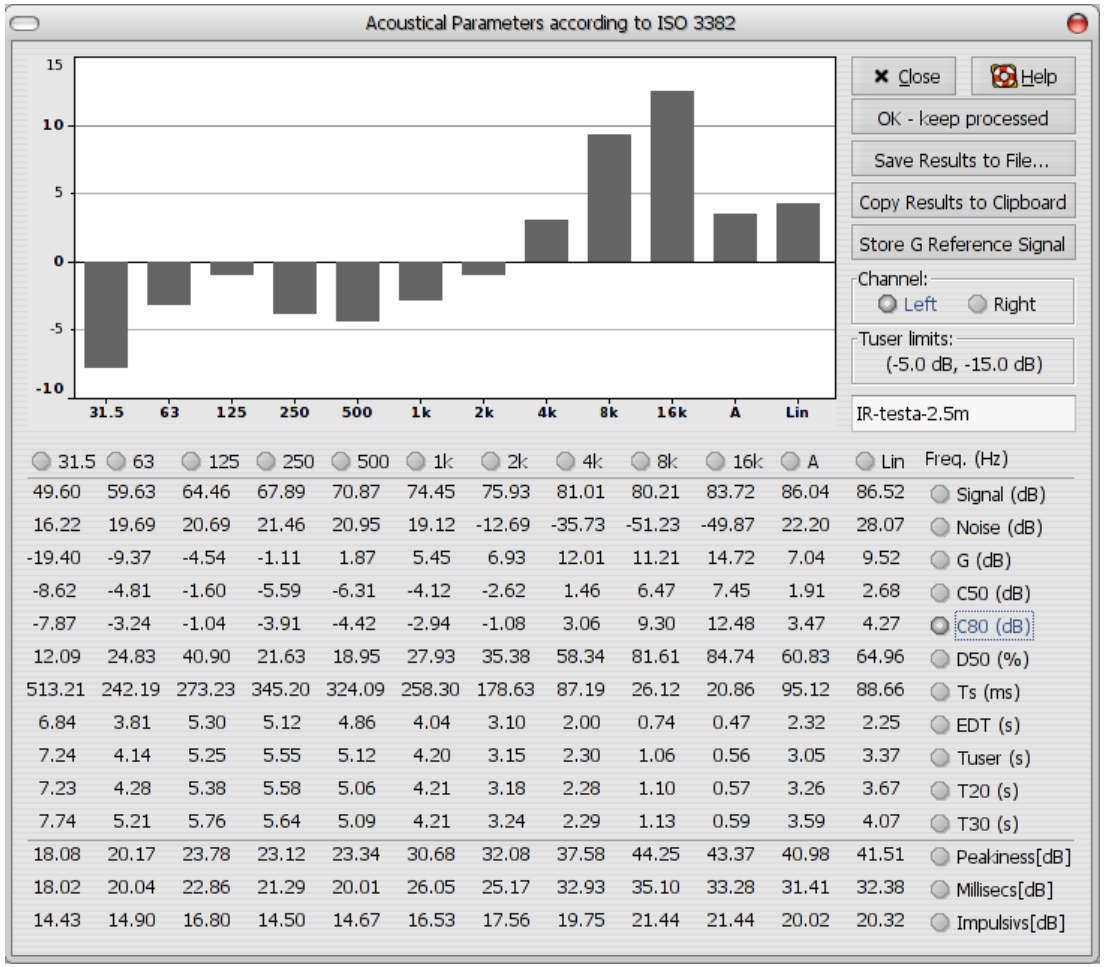
-93.25	-84.25	-80.24	-75.78	-72.65	-69.52	-68.76	-65.98	-71.76	-71.19	-71.23	-69.31	LG (dB)

Aurora For Audacity: Graphbar



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7.74	5.21	5.76	5.64	5.09	4.21	3.24	2.29	1.13	0.59	3.59	4.07	T30 (s)
18.08	20.17	23.78	23.12	23.34	30.68	32.08	37.58	44.25	43.37	40.98	41.51	Peakiness[dB]
18.02	20.04	22.86	21.29	20.01	26.05	25.17	32.93	35.10	33.28	31.41	32.38	Millisecs[dB]
14.43	14.90	16.80	14.50	14.67	16.53	17.56	19.75	21.44	21.44	20.02	20.32	Impulsivs[dB]

Comparison Of Results

A confrontation has been made with two commercial software:

- Brüel & Kjær *Dirac* version 3.0
- Morset Sound Development *WinMLS 2004* version 1.07

Comparison Of Results - T_{20} @ 250 Hz

		Acoust. Param.	*B&K Dirac 3.0*	*WinMLS 2004*
EDT	[s]	4.82	4.76	4.74
T_{20}	[s]	5.02	5.01	5.01
T_{30}	[s]	4.98	4.96	4.97
C_{80}	[dB]	- 4.40	-4.24	-4.8
D_{50}	[-]	0.20	0.20	0.19
ST_E	[dB]	3.26	4.05	-
ST_L	[dB]	8.70	9.63	-
$IACC_E$	[-]	0.34	-	0.31

Comparison Of Results - T_{20} @ 1 kHz

		Acoust. Param.	*B&K Dirac 3.0*	*WinMLS 2004*
EDT	[s]	4.44	4.41	4.38
T_{20}	[s]	4.10	4.10	4.11
T_{30}	[s]	4.20	4.19	4.22
C_{80}	[dB]	- 2.55	-2.65	-2.8
D_{50}	[-]	0.30	0.30	0.29
ST_E	[dB]	0.58	0.75	-
ST_L	[dB]	5.95	6.32	-
$IACC_E$	[-]	0.38	-	0.40

Comparison Of Results - T_{20} @ 4 kHz

		Acoust. Param.	*B&K Dirac 3.0*	*WinMLS 2004*
EDT	[s]	2.18	2.18	2.08
T_{20}	[s]	2.22	2.23	2.23
T_{30}	[s]	2.25	2.26	2.27
C_{80}	[dB]	2.93	2.93	2.6
D_{50}	[-]	0.60	0.60	0.59
ST_E	[dB]	-2.60	-2.57	-
ST_L	[dB]	-1.96	-1.91	-
$IACC_E$	[-]	0.61	-	0.61

Other Plugins Are Waiting...

Our goal is a complete *multiplatform* acoustical measurements toolset.

or, in other words,

The conversion of the entire Aurora suite.